

SCIENCE

FRIDAY, SEPTEMBER 8, 1911

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ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE¹

It is now eighty years since this association first met at York, under the presidency of Earl Fitzwilliam. The object of the association was then explicitly stated: "To give a stronger impulse and a more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers, to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

In 1831 the workers in the domain of science were relatively few. The Royal Society, which was founded by Dr. Willis, Dr. Wilkins, and others, under the name of the "Invisible, or Philosophical College," about the year 1645, and which was incorporated in December, 1660, with the approval of King Charles II., was almost the only meeting-place for those interested in the progress of science; and its *Philosophical Transactions*, begun in March, 1664-5, almost the only medium of publication. Its character was described in the following words of a contemporary poem:

"This noble learned Corporation
Not for themselves are thus combined
To prove all things by demonstration
But for the public good of the nation
And general benefit of mankind."

The first to hive off from the Royal Society was the Linnean Society for the promotion of botanical studies, founded in 1788 by Sir James Edward Smith, Sir

¹ Portsmouth, 1911.

Joseph Banks, and other Fellows of the Royal Society; in 1807 it was followed by the Geological Society; at a later date the Society of Antiquaries, the Chemical, the Zoological, the Physical, the Mathematical, and many other societies were founded. And it was felt by those capable of forming a judgment that, as well expressed by Lord Playfair at Aberdeen in 1885, "Human progress is so identified with scientific thought, both in its conception and realization, that it seems as if they were alternative terms in the history of civilization." This is only an echo through the ages of an utterance of the great Englishman, Roger Bacon, who wrote in 1250 A.D.: "Experimental science has three great prerogatives over all other sciences: it verifies conclusions by direct experiment; it discovers truths which they could never reach; and it investigates the secrets of Nature, and opens to us a knowledge of the past and of the future."

The world has greatly changed since 1831; the spread of railways and the equipment of numerous lines of steamships have contributed to the peopling of countries at that time practically uninhabited. Moreover, not merely has travelling been made almost infinitely easier, but communication by post has been enormously expedited and cheapened; and the telegraph, the telephone, and wireless telegraphy have simplified as well as complicated human existence. Furthermore, the art of engineering has made such strides that the question "Can it be done?" hardly arises, but rather "Will it pay to do it?" In a word, the human race has been familiarized with the applications of science; and men are ready to believe almost anything, if brought forward in its name.

Education, too, in the rudiments of science has been introduced into almost all schools; young children are taught the

elements of physics and chemistry. The institution of a Section for Education in our Association (L) has had for its object the organizing of such instruction, and much useful advice has been proffered. The problem is, indeed, largely an educational one; it is being solved abroad in various ways—in Germany and in most European states by elaborate governmental schemes dealing with elementary and advanced instruction, literary, scientific, and technical; and in the United States and in Canada by the far-sightedness of the people: both employers and employees recognize the value of training and of originality, and on both sides sacrifices are made to ensure efficiency.

In England we have made technical education a local, not an imperial question; instead of half a dozen first-rate institutions of university rank, we have a hundred, in which the institutions are necessarily understaffed, in which the staffs are mostly overworked and underpaid; and the training given is that not for captains of industry, but for workmen and foremen. "Efficient captains cannot be replaced by a large number of fairly good corporals." Moreover, to induce scholars to enter these institutions, they are bribed by scholarships, a form of pauperization practically unknown in every country but our own; and to crown the edifice, we test results by examinations of a kind not adapted to gauge originality and character (if, indeed, these can ever be tested by examination), instead of, as on the Continent and in America, trusting the teachers to form an honest estimate of the capacity and ability of each student, and awarding honors accordingly.

The remedy lies in our own hands. Let me suggest that we exact from all gainers of university scholarships an undertaking that, if and when circumstances permit,

they will repay the sum which they have received as a scholarship, bursary, or fellowship. It would then be possible for an insurance company to advance a sum representing the capital value, *viz.*, 7,464,931*l.*, of the scholarships, reserving, say, twenty per cent. for non-payment, the result of mishap or death. In this way a sum of over six million pounds, of which the interest is now expended on scholarships, would be available for university purposes. This is about one-fourth of the sum of twenty-four millions stated by Sir Norman Lockyer at the Southport meeting as necessary to place our university education on a satisfactory basis. A large part of the income of this sum should be spent in increasing the emoluments of the chairs; for, unless the income of a professor is made in some degree commensurate with the earnings of a professional man who has succeeded in his profession, it is idle to suppose that the best brains will be attracted to the teaching profession. And it follows that unless the teachers occupy the first rank, the pupils will not be stimulated as they ought to be.

Again, having made the profession of a teacher so lucrative as to tempt the best intellects in the country to enter it, it is clear that such men are alone capable of testing their pupils. The modern system of "external examinations," known only in this country, and answerable for much of its lethargy, would disappear; schools of thought would arise in all subjects, and the intellectual as well as the industrial prosperity of our nation would be assured. As things are, can we wonder that as a nation we are not scientific? Let me recommend those of my hearers who are interested in the matter to read a recent report on Technical Education by the Science Guild.

I venture to think that, in spite of the

remarkable progress of science and of its applications, there never was a time when missionary effort was more needed. Although most people have some knowledge of the results of scientific inquiry, few, very few, have entered into its spirit. We all live in hope that the world will grow better as the years roll on. Are we taking steps to secure the improvement of the race? I plead for recognition of the fact that progress in science does not only consist in accumulating information which may be put to practical use, but in developing a spirit of prevision, in taking thought for the morrow; in attempting to forecast the future, not by vague surmise, but by orderly marshalling of facts, and by deducing from them their logical outcome; and chiefly in endeavoring to control conditions which may be utilized for the lasting good of our people. We must cultivate a belief in the "application of trained intelligence to all forms of national activity."

The council of the association has had under consideration the formation of a section of agriculture. For some years this important branch of applied science, borrowing as it does from botany, from physics, from chemistry, and from economics, has in turn enjoyed the hospitality of each of these sections, itself having been made a subsection of one of these more definite sciences. It is proposed this year to form an agricultural section. Here, there is need of missionary effort; for our visits to our colonies have convinced many of us that much more is being done for the farmer in the newer parts of the British Empire than at home. Agriculture is, indeed, applied botany, chemistry, entomology, and economics; and has as much right to independent treatment as has engineering, which may be strictly regarded as applied physics.

The question has often been debated whether the present method of conducting

our proceedings is the one best adapted to gain our ends. We exist professedly "to give a stronger impulse and a more systematic direction to scientific inquiry." The council has had under consideration various plans framed with the object of facilitating our work, and the result of its deliberations will be brought under your attention at a later date. To my mind, the greatest benefit bestowed on science by our meetings is the opportunity which they offer for friendly and unrestrained intercourse, not merely between those following different branches of science, but also with persons who, though not following science professionally, are interested in its problems. Our meetings also afford an opportunity for younger men to make the acquaintance of older men. I am afraid that we who are no longer in the spring of our lifetime, perhaps from modesty, perhaps through carelessness, often do not sufficiently realize how stimulating to a young worker a little sympathy can be; a few words of encouragement go a long way. I have in my mind words which encouraged me as a young man, words spoken by the leaders of associations now long past—by Playfair, by Williamson, by Frankland, by Kelvin, by Stokes, by Francis Galton, by Fitzgerald and many others. Let me suggest to my older scientific colleagues that they should not let such pleasant opportunities slip.

Since our last meeting the Association has to mourn the loss by death of many distinguished members. Among these are:

Dr. John Beddoe, who served on the council from 1870 to 1875, has recently died at a ripe old age, after having achieved a world-wide reputation by his magnificent work in the domain of anthropology.

Sir Rubert Boyce, called away at a comparatively early age in the middle of his work, was for long a colleague of mine at

University College, and was one of the staff of the Royal Commission on Sewage Disposal. The service he rendered science in combating tropical diseases is well known.

Sir Francis Galton died at the beginning of the year, at the advanced age of 89. His influence on science has been characterized by Professor Karl Pearson in his having maintained the idea that exact quantitative methods could—nay, must—be applied to many branches of science which had been held to be beyond the field of either mathematical or physical treatment. Sir Francis was general secretary of this association from 1863 to 1868; he was president of Section E in 1862, and again in 1872; he was president of Section H in 1885; but, although often asked to accept the office of president of the association, his consent could never be obtained. Galton's name will always be associated with that of his friend and relative, Charles Darwin, as one of the most eminent and influential of English men of science.

Professor Thomas Rupert Jones, also, like Galton, a member of this association since 1860, and in 1891 president of the Geological Section, died in April last at the advanced age of 91. Like Dr. Beddoe, he was a medical man with wide scientific interests. He became a distinguished geologist, and for many years edited the *Quarterly Journal* of the Geological Society.

Professor Story Maskelyne, at one time a diligent frequenter of our meetings, and a member of the council from 1874 to 1880, was a celebrated mineralogist and crystallographer. He died at the age of 88. The work which he did in the University of Oxford and at the British Museum is well known. In his later life he entered Parliament.

Dr. Johnstone Stoney, president of Section A in 1897, died on July 1, in his 86th year. He was one of the originators of the modern view of the nature of electricity,

having given the name "electron" to its unit as far back as 1874. His investigations dealt with spectroscopy and allied subjects, and his philosophic mind led him to publish a scheme of ontology which, I venture to think, must be acknowledged to be the most important work which has ever been done on that difficult subject.

Among our corresponding members we have lost Professor Bohr, of Copenhagen; Professor Brühl, of Heidelberg; Hofrat Dr. Caro, of Berlin; Professor Fittig, of Strassburg; and Professor Van't Hoff, of Berlin. I can not omit to mention that veteran of science, Professor Cannizzaro, of Rome, whose work in the middle of last century placed chemical science on the firm basis which it now occupies.

I knew all these men, some of them intimately; and, if I have not ventured on remarks as to their personal qualities, it is because it may be said of all of them that they fought a good fight and maintained the faith that only by patient and unceasing scientific work is human progress to be hoped for.

It has been the usual custom of my predecessors in office either to give a summary of the progress of science within the past year or to attempt to present in intelligible language some aspect of the science in which they have themselves been engaged. I possess no qualifications for the former course, and I therefore ask you to bear with me while I devote some minutes to the consideration of ancient and modern views regarding the chemical elements. To many in my audience part of my story will prove an oft-told tale; but I must ask those to excuse me, in order that it may be in some wise complete.

In the days of the early Greeks the word "element" was applied rather to denote a property of matter than one of its constituents. Thus, when a substance was said

to contain fire, air, water, and earth (of which terms a childish game doubtless once played by all of us is a relic), it probably meant that they partook of the nature of the so-called elements. Inflammability showed the presence of concealed fire; the escape of "airs" when some substances are heated or when vegetable or animal matter is distilled no doubt led to the idea that these airs were imprisoned in the matters from which they escaped; hardness and permanence were ascribed to the presence of earth, while liquidity and fusibility were properties conveyed by the presence of concealed water. At a later date the "Spagyrics" added three "hypostatical principles" to the quadrilateral; these were "salt," "sulphur," and "mercury." The first conveyed solubility, and fixedness in fire; the second, inflammability; and the third, the power which some substances manifest of producing a liquid, generally termed "phlegm," on application of heat, or of themselves being converted into the liquid state by fusion.

It was Robert Boyle, in his "Skeptical Chymist," who first controverted these ancient and medieval notions, and who gave to the word "element" the meaning that it now possesses—the constituent of a compound. But in the middle of the seventeenth century chemistry had not advanced far enough to make his definition useful; for he was unable to suggest any particular substance as elementary. And, indeed, the main tenet of the doctrine of "phlogiston," promulgated by Stahl in the eighteenth century, and widely accepted, was that all bodies capable of burning or of being converted into a "calx," or earthy powder, did so in virtue of the escape of a subtle fluid from their pores; this fluid could be restored to the "calces" by heating them with other substances rich in phlogiston, such as charcoal, oil, flour and

the like. Stahl, however false his theory, had at least the merit of having constructed a reversible chemical equation: Metal — phlogiston = calx; calx + phlogiston = metal.

It is difficult to say when the first element was known to be an element. After Lavoisier's overthrow of the phlogistic hypothesis, the part played by oxygen, then recently discovered by Priestley and Scheele, came prominently forward. Loss of phlogiston was identified with oxidation; gain of phlogiston, with loss of oxygen. The scheme of nomenclature ("Méthode de Nomenclature chimique"), published by Lavoisier in conjunction with Guyton de Morveau, Berthollet and Fourcroy, created a system of chemistry out of a wilderness of isolated facts and descriptions. Shortly after, in 1789, Lavoisier published his "Traité de Chimie," and in the preface the words occur: "If we mean by 'elements' the simple and indivisible molecules of which bodies consist, it is probable that we do not know them; if, on the other hand, we mean the last term in analysis, then every substance which we have not been able to decompose is for us an element; not that we can be certain that bodies which we regard as simple are not themselves composed of two or even a larger number of elements, but because these elements can never be separated, or rather, because we have no means of separating them, they act, so far as we can judge, as elements; and we can not call them 'simple' until experiment and observation shall have furnished a proof that they are so."

The close connection between "crocus of Mars" and metallic iron, the former named by Lavoisier "oxyde de fer," and similar relations between metals and their oxides, made it likely that bodies which reacted as oxides in dissolving in acids and form-

ing salts must also possess a metallic substratum. In October, 1807, Sir Humphry Davy proved the correctness of this view for soda and potash by his famous experiment of splitting these bodies by a powerful electric current into oxygen and hydrogen on the one hand, and the metals sodium and potassium on the other. Calcium, barium, strontium and magnesium were added to the list as constituents of the oxides, lime, barytes, strontia, and magnesia. Some years later Scheele's "dephlogisticated marine acid," obtained by heating pyrolusite with "spirit of salt," was identified by Davy as in all likelihood elementary. His words are: "All the conclusions which I have ventured to make respecting the undecomposed nature of oxymuriatic gas are, I conceive, entirely confirmed by these new facts." "It has been judged most proper to suggest a name founded upon one of its obvious and characteristic properties, its color, and to call it chlorine." The subsequent discovery of iodine by Courtois in 1812, and of bromine by Balard in 1826, led to the inevitable conclusion that fluorine, if isolated, should resemble the other halogens in properties, and much later, in the able hands of Moissan, this was shown to be true.

The modern conception of the elements was much strengthened by Dalton's revival of the Greek hypothesis of the atomic constitution of matter, and the assigning to each atom a definite weight. This momentous step for the progress of chemistry was taken in 1803; the first account of the theory was given to the public with Dalton's consent in the third edition of Thomas Thomson's "System of Chemistry" in 1807; it was subsequently elaborated in the first volume of Dalton's own "System of Chemical Philosophy," published in 1808. The notion that compounds consisted of aggregations of atoms of elements, united

in definite or multiple proportions, familiarized the world with the conception of elements as the bricks of which the universe is built. Yet the more daring spirits of that day were not without hope that the elements themselves might prove decomposable. Davy, indeed, went so far as to write in 1811: "It is the duty of the chemist to be bold in pursuit; he must recollect how contrary knowledge is to what appears to be experience. . . . To enquire whether the elements be capable of being composed and decomposed is a grand object of true philosophy." And Faraday, his great pupil and successor, at a later date, 1815, was not behind Davy in his aspirations, when he wrote: "To decompose the metals, to re-form them, and to realize the once absurd notion of transformation—these are the problems now given to the chemist for solution."

Indeed, the ancient idea of the unitary nature of matter was in those days held to be highly probable. For attempts were soon made to demonstrate that the atomic weights were themselves multiples of that of one of the elements. At first the suggestion was that oxygen was the common basis; and later, when this supposition turned out to be untenable, the claims of hydrogen were brought forward by Prout. The hypothesis was revived in 1842 when Liebig and Redtenbacher, and subsequently Dumas, carried out a revision of the atomic weights of some of the commoner elements, and showed that Berzelius was in error in attributing to carbon the atomic weight 12.25, instead of 12.00. Of recent years a great advance in the accuracy of the determinations of atomic weights has been made, chiefly owing to the work of Richards and his pupils, of Gray, and of Guye and his collaborators, and every year an international committee publishes a table in which the most probable numbers are given

on the basis of the atomic weight of oxygen being taken as sixteen. In the table for 1911, of eighty-one elements no fewer than forty-three have recorded atomic weights within one-tenth of a unit above or below an integral number. My mathematical colleague, Karl Pearson, assures me that the probability against such a condition being fortuitous is 20,000 millions to one.

The relation between the elements has, however, been approached from another point of view. After preliminary suggestions by Döbereiner, Dumas and others, John Newlands in 1862 and the following years arranged the elements in the numerical order of their atomic weights, and published in the *Chemical News* of 1863 what he termed his law of octaves—that every eighth element, like the octave of a musical note, is in some measure a repetition of its forerunner. Thus, just as C on the third space is the octave of C below the line, so potassium, in 1863 the eighth known element numerically above sodium, repeats the characters of sodium, not only in its physical properties—color, softness, ductility, malleability, etc.—but also in the properties of its compounds, which, indeed, resemble each other very closely. The same fundamental notion was reproduced at a later date and independently by Lothar Meyer and Dmitri Mendeléeff; and to accentuate the recurrence of such similar elements in *periods*, the expression "the periodic system of arranging the elements" was applied to Newlands's arrangement in octaves. As everyone knows, by help of this arrangement Mendeléeff predicted the existence of then unknown elements, under the names of *eka-boron*, *eka-aluminium* and *eka-silicon*, since named *scandium*, *gallium* and *germanium*, by their discoverers, Cleve, Lecoq de Boisbaudran, and Winckler.

It might have been supposed that our knowledge of the elements was practically

complete; that perhaps a few more might be discovered to fill the outstanding gaps in the periodic table. True, a puzzle existed and still exists in the classification of the "rare earths," oxides of metals occurring in certain minerals; these metals have atomic weights between 139 and 180, and their properties preclude their arrangement in the columns of the periodic table. Besides these, the discovery of the inert gases of the atmosphere, of the existence of which Johnstone Stoney's spiral curve, published in 1888, pointed a forecast, joined the elements like sodium and potassium, strongly electro-negative, to those like fluorine and chlorine, highly electro-positive, by a series of bodies electrically as well as chemically inert, and neon, argon, krypton, and xenon formed links between fluorine and sodium, chlorine and potassium, bromine and rubidium, and iodine and caesium.

Including the inactive gases, and adding the more recently discovered elements of the rare earths, and radium, of which I shall have more to say presently, there are eighty-four definite elements, all of which find places in the periodic table, if merely numerical values be considered. Between lanthanum, with atomic weight 139, and tantalum, 181, there are in the periodic table seventeen spaces; and although it is impossible to admit, on account of their properties, that the elements of the rare earths can be distributed in successive columns (for they all resemble lanthanum in properties), yet there are now fourteen such elements; and it is not improbable that other three will be separated from the complex mixture of their oxides by further work. Assuming that the metals of the rare earths fill these seventeen spaces, how many still remain to be filled? We will take for granted that the atomic weight of uranium, 238.5, which is the

highest known, forms an upper limit not likely to be surpassed. It is easy to count the gaps; there are eleven.

But we are confronted by an *embarras de richesse*. The discovery of radioactivity by Henri Becquerel, of radium by the Curies, and the theory of the disintegration of the radioactive elements, which we owe to Rutherford and Soddy, have indicated the existence of no fewer than twenty-six elements hitherto unknown. To what places in the periodic table can they be assigned?

But what proof have we that these substances are elementary? Let us take them in order.

Beginning with radium, its salts were first studied by Madame Curie; they closely resemble those of barium—sulphate, carbonate, and chromate insoluble; chloride and bromide similar in crystalline form to chloride and bromide of barium; metal, recently prepared by Madame Curie, white, attacked by water, and evidently of the type of barium. The atomic weight, too, falls into its place; as determined by Madame Curie and by Thorpe, it is 89.5 units higher than that of barium; in short, there can be no doubt that radium fits the periodic table, with an atomic weight of about 226.5. It is an undoubted element.

But it is a very curious one. For it is *unstable*. Now, stability was believed to be the essential characteristic of an element. Radium, however, disintegrates—that is, changes into other bodies, and at a constant rate. If 1 gram of radium is kept for 1,760 years, only half a gram will be left at the end of that time; half of it will have given other products. What are they? We can answer that question. Rutherford and Soddy found that it gives a condensable gas, which they named "radium-emanation"; and Soddy and I, in 1903, discovered that, in addition, it evolves helium,

one of the inactive series of gases, like argon. Helium is an undoubted element, with a well-defined spectrum; it belongs to a well-defined series. And radium-emanation, which was shown by Rutherford and Soddy to be incapable of chemical union, has been liquefied and solidified in the laboratory of University College, London, its spectrum has been measured and its density determined. From the density the atomic weight can be calculated, and it corresponds with that of a congener of argon, the whole series being: helium, 4; neon, 20; argon, 40; krypton, 83; xenon, 130; unknown, about 178; and niton (the name proposed for the emanation to recall its connection with its congeners, and its phosphorescent properties), about 222.4. The formation of niton from radium would therefore be represented by the equation: $\text{radium (226.4)} = \text{helium (4)} + \text{niton (222.4)}$.

Niton, in its turn, disintegrates, or decomposes, and at a rate much more rapid than the rate of radium; half of it has changed in about four days. Its investigation, therefore, had to be carried out very rapidly, in order that its decomposition might not be appreciable while its properties were being determined. Its product of change was named by Rutherford "radium A," and it is undoubtedly deposited from niton as a metal, with simultaneous evolution of helium; the equation would therefore be: $\text{niton (222.4)} = \text{helium (4)} + \text{radium A (218.4)}$. But it is impossible to investigate radium A chemically, for in three minutes it has half changed into another solid substance, radium B, again giving off helium. This change would be represented by the equation: $\text{radium A (218.4)} = \text{helium (4)} + \text{radium B (214.4)}$. Radium B, again, can hardly be examined chemically, for in twenty-seven minutes it has half changed into radium C¹. In this

case, however, no helium is evolved; only atoms of negative electricity, to which the name "electrons" has been given by Dr. Stoney, and these have minute weight which, although approximately ascertainable, at present has defied direct measurement. Radium C¹ has a half-life of 19.5 minutes; too short, again, for chemical investigation; but it changes into radium C², and in doing so, each atom parts with a helium atom; hence the equation: $\text{—radium C}^1 (214.4) = \text{helium (4)} + \text{radium C}^2 (210.4)$. In 2.5 minutes, radium C² is half gone, parting with electrons, forming radium D. Radium D gives the chemist a chance, for its half-life is no less than sixteen and a half years. Without parting with anything detectable, radium D passes into radium E, of which the half-life period is five days; and lastly radium E changes spontaneously into radium F, the substance to which Madame Curie gave the name "polonium" in allusion to her native country, Poland. Polonium, in its turn, is half changed in 140 days with loss of an atom of helium into an unknown metal, supposed to be possibly lead. If that be the case, the equation would run: $\text{polonium (210.4)} = \text{helium (4)} + \text{lead (206.4)}$. But the atomic weight of lead is 207.1, and not 206.4; however, it is possible that the atomic weight of radium is 227.1, and not 226.4.

We have another method of approaching the same subject. It is practically certain that the progenitor of radium is uranium; and that the transformation of uranium into radium involves the loss of three alpha particles; that is, of three atoms of helium. The atomic weight of helium may be taken as one of the most certain; it is 3.994, as determined by Mr. Watson, in my laboratories. Three atoms would therefore weigh 11.98, practically 12. There is, however, still some uncertainty in the atomic weight of uranium; Richards and Merigold make

it 239.4; but the general mean, calculated by Clarke, is 239.0. Subtracting 12 from these numbers, we have the values 227.0, and 227.4 for the atomic weight of radium. It is as yet impossible to draw any certain conclusion.

The importance of the work which will enable a definite and sure conclusion to be drawn is this: For the first time, we have accurate knowledge as to the descent of some of the elements. Supposing the atomic weight of uranium to be certainly 239, it may be taken as proved that in losing three atoms of helium, radium is produced, and, if the change consists solely in the loss of the three atoms of helium, the atomic weight of radium must necessarily be 227. But it is known that β -rays, or electrons, are also parted with during this change; and electrons have weight. How many electrons are lost is unknown; therefore, although the weight of an electron is approximately known, it is impossible to say how much to allow for in estimating the atomic weight of radium. But it is possible to solve this question indirectly, by determining exactly the atomic weights of radium and of uranium; the difference between the atomic weight of radium *plus* 12, *i. e.*, plus the weight of three atoms of helium, and that of uranium, will give the weight of the number of electrons which escape. Taking the most probable numbers available, *viz.*, 239.4 for uranium and 226.8 for radium, and adding 12 to the latter, the weight of the escaping electrons would be 0.6.

The correct solution of this problem would in great measure clear up the mystery of the irregularities in the periodic table, and would account for the deviations from Prout's law, that the atomic weights are multiples of some common factor or factors. I also venture to suggest that it would throw light on allotropy,

which in some cases at least may very well be due to the loss or gain of electrons, accompanied by a positive or negative heat-change. Incidentally, this suggestion would afford places in the periodic table for the somewhat overwhelming number of pseudo-elements the existence of which is made practically certain by the disintegration hypothesis. Of the twenty-six elements derived from uranium, thorium, and actinium, ten, which are formed by the emission of electrons alone, may be regarded as allotropes or pseudo-elements; this leaves sixteen, for which sixteen or seventeen gaps would appear to be available in the periodic table, provided the reasonable supposition be made that a second change in the length of the periods has taken place. It is above all things certain that it would be a fatal mistake to regard the existence of such elements as irreconcilable with the periodic arrangement, which has rendered to systematic chemistry such signal service in the past.

Attention has repeatedly been drawn to the enormous quantity of energy stored up in radium and its descendants. That in its emanation niton is such that if what it parts with as heat during its disintegration were available, it would be equal to three and a half million times the energy available by the explosion of an equal volume of detonating gas—a mixture of one volume of oxygen with two volumes of hydrogen. The major part of this energy comes, apparently, from the expulsion of particles (that is, of atoms of helium) with enormous velocity. It is easy to convey an idea of this magnitude in a form more realizable, by giving it a somewhat mechanical turn. Suppose that the energy in a ton of radium could be utilized in thirty years, instead of being evolved at its invariable slow rate of 1,760 years for half-disintegration, it would suffice to propel a ship

of 15,000 tons, with engines of 15,000 horsepower, at the rate of 15 knots an hour, for 30 years—practically the lifetime of the ship. To do this actually requires a million and a half tons of coal.

It is easily seen that the virtue of the energy of the radium consists in the small weight in which it is contained; in other words, the radium-energy is in an enormously concentrated form. I have attempted to apply the energy contained in niton to various purposes; it decomposes water, ammonia, hydrogen chloride and carbon dioxide, each into its constituents; further experiments on its action on salts of copper appeared to show that the metal copper was converted partially into lithium, a metal of the sodium column; and similar experiments, of which there is not time to speak, indicate that thorium, zirconium, titanium and silicon are degraded into carbon; for solutions of compounds of these, mixed with niton, invariably generated carbon dioxide; while cerium, silver, mercury and some other metals gave none. One can imagine the very atoms themselves, exposed to bombardment by enormously quickly moving helium atoms failing to withstand the impacts. Indeed, the argument *a priori* is a strong one; if we know for certain that radium and its descendants decompose spontaneously, evolving energy, why should not other more stable elements decompose when subjected to enormous strains?

This leads to the speculation whether, if elements are capable of disintegration, the world may not have at its disposal a hitherto unsuspected source of energy. If radium were to evolve its stored-up energy at the same rate that gun-cotton does, we should have an undreamt-of explosive; could we control the rate we should have a useful and potent source of energy, provided always that a sufficient supply of

radium were forthcoming. But the supply is certainly a very limited one; and it can be safely affirmed that the production will never surpass half an ounce a year. If, however, the elements which we have been used to consider as permanent are capable of changing with evolution of energy; if some form of catalyzer could be discovered which would usefully increase their almost inconceivably slow rate of change, then it is not too much to say that the whole future of our race would be altered.

The whole progress of the human race has indeed been due to individual members discovering means of concentrating energy, and of transforming one form into another. The carnivorous animals strike with their paws and crush with their teeth; the first man who aided his arm with a stick in striking a blow discovered how to concentrate his small supply of kinetic energy; the first man who used a spear found that its sharp point in motion represented a still more concentrated form; the arrow was a further advance, for the spear was then propelled by mechanical means; the bolt of the crossbow, the bullet shot forth by compressed hot gas, first derived from black powder, later, from high explosives; all these represent progress. To take another sequence: the preparation of oxygen by Priestley applied energy to oxide of mercury in the form of heat; Davy improved on this when he concentrated electrical energy into the tip of a thin wire by aid of a powerful battery, and isolated potassium and sodium.

Great progress has been made during the past century in effecting the conversion of one form of energy into others, with as little useless expenditure as possible. Let me illustrate by examples: A good steam engine converts about one eighth of the potential energy of the fuel into useful work; seven eighths are lost as unused heat

and useless friction. A good gas-engine utilizes more than one third of the total energy in the gaseous fuel; two thirds are uneconomically expended. This is a universal proposition; in order to effect the conversion from one form of energy into another, some energy must be expended uneconomically. If A is the total energy which it is required to convert; if B is the energy into which it is desired to convert A ; then a certain amount of energy, C , must be expended to effect the conversion. In short, $A = B + C$. It is eminently desirable to keep C , the useless expenditure, as small as possible; it can never equal zero, but it can be made small. The ratio of C to B (the economic coefficient) should therefore be as large as is attainable.

The middle of the nineteenth century will always be noted as the beginning of the golden age of science; the epoch when great generalizations were made, of the highest importance on all sides, philosophical, economic and scientific. Carnot, Clausius, Helmholtz, Julius Robert Mayer abroad, and the Thomsons, Lord Kelvin and his brother James, Rankine, Tait, Joule, Clerk Maxwell and many others at home, laid the foundations on which the splendid structure has been erected. That the latent energy of fuel can be converted into energy of motion by means of the steam engine is what we owe to Newcomen and Watt; that the kinetic energy of the fly-wheel can be transformed into electrical energy was due to Faraday, and to him, too, we are indebted for the reconversion of electrical energy into mechanical work; and it is this power of work which gives us leisure, and which enables a small country like ours to support the population which inhabits it.

I suppose that it will be generally granted that the commonwealth of Athens attained a high-water mark in literature

and thought, which has never yet been surpassed. The reason is not difficult to find; a large proportion of its people had ample leisure, due to ample means; they had time to think and time to discuss what they thought. How was this achieved? The answer is simple: each Greek freeman had on an average at least five helots who did his bidding, who worked his mines, looked after his farm, and, in short, saved him from manual labor. Now, we in Britain are much better off; the population of the British Isles is in round numbers 45 millions; there are consumed in our factories at least 50 million tons of coal annually, and "it is generally agreed that the consumption of coal per indicated horse-power per hour is on an average about 5 lb." (Royal Commission on Coal Supplies, Part I.) This gives seven million horse-power per year. How many man-power are equal to a horse-power? I have arrived at an estimate thus: A Bhutanese can carry 230 lb. *plus* his own weight, in all 400 lb., up a hill 4,000 feet high in eight hours; this is equivalent to about one twenty-fifth of a horse-power; seven million horse-power are therefore about 175 million man-power. Taking a family as consisting on the average of five persons, our 45 millions would represent nine million families; and dividing the total man-power by the number of families, we must conclude that each British family has, on the average, nearly twenty "helots" doing his bidding, instead of the five of the Athenian family. We do not appear, however, to have gained more leisure thereby, but it is this that makes it possible for the British Isles to support the population which it does.

We have in this world of ours only a limited supply of stored-up energy; in the British Isles a very limited one—namely, our coalfields. The rate at which this sup-

ply is being exhausted has been increasing very steadily for the last forty years, as any one can prove by mapping the data given on page 27, table D, of the General Report of the Royal Commission on Coal Supplies (1906). In 1870 110 million tons were mined in Great Britain, and ever since the amount has increased by three and a third million tons a year. The available quantity of coal in the proved coalfields is very nearly 100,000 million tons; it is easy to calculate that if the rate of working increases as it is doing our coal will be completely exhausted in 175 years. But, it will be replied, the rate of increase will slow down. Why? It has shown no sign whatever of slackening during the last forty years. Later, of course, it must slow down, when coal grows dearer owing to approaching exhaustion. It may also be said that 175 years is a long time; why, I myself have seen a man whose father fought in the '45 on the Pretender's side, nearly 170 years ago! In the life of a nation 175 years is a span.

This consumption is still proceeding at an accelerated rate. Between 1905 and 1907 the amount of coal raised in the United Kingdom increased from 236 to 268 million tons, equal to six tons per head of the population, against three and a half tons in Belgium, two and a half tons in Germany and one ton in France. Our commercial supremacy and our power of competing with other European nations are obviously governed, so far as we can see, by the relative price of coal; and when our prices rise, owing to the approaching exhaustion of our supplies, we may look forward to the near approach of famine and misery.

Having been struck some years ago with the optimism of my non-scientific friends as regards our future, I suggested that a committee of the British Science Guild

should be formed to investigate our available sources of energy. This guild is an organization, founded by Sir Norman Lockyer, after his tenure of the presidency of this association, for the purpose of endeavoring to impress on our people and their government the necessity of viewing problems affecting the race and the state from the standpoint of science; and the definition of science in this, as in other connections, is simply the acquisition of knowledge, and orderly reasoning on experience already gained and on experiments capable of being carried out, so as to forecast and control the course of events; and, if possible, to apply this knowledge to the benefit of the human race.

The Science Guild has enlisted the services of a number of men, each eminent in his own department, and each has now reported on the particular source of energy of which he has special knowledge.

Besides considering the uses of coal and its products, and how they may be more economically employed, in which branches the Hon. Sir Charles Parsons, Mr. Dugald Clerk, Sir Boverton Redwood, Dr. Beilby, Dr. Hele-Shaw, Professor Vivian Lewes and others have furnished reports, the following sources of energy have been brought under review: The possibility of utilizing the tides; the internal heat of the earth; the winds; solar heat; water-power; the extension of forests, and the use of wood and peat as fuels; and lastly, the possibility of controlling the undoubted but almost infinitely slow disintegration of the elements, with the view of utilizing their stored-up energy.

However interesting a detailed discussion of these possible sources of energy might be, time prevents my dwelling on them. Suffice it to say that the Hon. R. J. Strutt has shown that in this country at least it would be impracticable to attempt

to utilize terrestrial heat from boreholes; others have deduced that from the tides, the winds and water-power small supplies of energy are no doubt obtainable, but that, in comparison with that derived from the combustion of coal, they are negligible; nothing is to be hoped for from the direct utilization of solar heat in this temperate and uncertain climate; and it would be folly to consider seriously a possible supply of energy in a conceivable acceleration of the liberation of energy by atomic change. It looks utterly improbable, too, that we shall ever be able to utilize the energy due to the revolution of the earth on her axis, or to her proper motion round the sun.

Attention should undoubtedly be paid to forestry, and to the utilization of our stores of peat. On the continent, the forests are largely the property of the state; it is unreasonable, especially in these latter days of uncertain tenure of property, to expect any private owner of land to invest money in schemes which would at best only benefit his descendants, but which, under our present trend of legislation, do not promise even that remote return. Our neighbors and rivals, Germany and France, spend annually 2,200,000*l.* on the conservation and utilization of their forests; the net return is 6,000,000*l.* There is no doubt that we could imitate them with advantage. Moreover, an increase in our forests would bring with it an increase in our water-power; for without forest land rain rapidly reaches the sea, instead of distributing itself, so as to keep the supply of water regular, and so more easily utilized.

Various schemes have been proposed for utilizing our deposits of peat: I believe that in Germany the peat industry is moderately profitable; but our humid climate does not lend itself to natural evaporation of most of the large amount of water contained in peat, without which processes of distillation prove barely remunerative.

We must therefore rely chiefly on our coal reserve for our supply of energy, and for the means of supporting our population; and it is to the more economical use of coal that we must look, in order that our life as a nation may be prolonged. We can economize in many ways: By the substitution of turbine engines for reciprocating engines, thereby reducing the coal required per horse-power from 4 to 5 lb. to $1\frac{1}{2}$ or 2 lb.; by the further replacement of turbines by gas engines, raising the economy to 30 per cent. of the total energy available in the coal, that is, lowering the coal consumption per horse-power to 1 or $1\frac{1}{4}$ lb.; by creating the power at the pit-mouth, and distributing it electrically, as is already done in the Tyne district. Economy can also be effected in replacing "bee-hive" coke ovens by recovery ovens; this is rapidly being done; and Dr. Beilby calculates that in 1909 nearly six million tons of coal, out of a total of sixteen to eighteen millions, were coked in recovery ovens, thus effecting a saving of two to three million tons of fuel annually. Progress is also being made in substituting gas for coal or coke in metallurgical, chemical and other works. But it must be remembered that for economic use, gaseous fuel must not be charged with the heavy costs of piping and distribution.

The domestic fire problem is also one which claims our instant attention. It is best grappled with from the point of view of smoke. Although the actual loss of thermal energy in the form of smoke is small—at most less than a half per cent. of the fuel consumed—still the presence of smoke is a sign of waste of fuel and careless stoking. In works, mechanical stokers which ensure regularity of firing and complete combustion of fuel are more and more widely replacing hand-firing. But we are still utterly wasteful in our consumption of fuel in domestic fires. There is prob-

ably no single remedy applicable; but the introduction of central heating, of gas fires and of grates which permit of better utilization of fuel will all play a part in economizing our coal. It is open to argument whether it might not be wise to hasten the time when smoke is no more by imposing a sixpenny fine for each offence; an instantaneous photograph could easily prove the offense to have been committed; and the imposition of the fine might be delayed until three warnings had been given by the police.

Now I think that what I wish to convey will be best expressed by an allegory. A man of mature years who has surmounted the troubles of childhood and adolescence without much disturbance to his physical and mental state, gradually becomes aware that he is suffering from loss of blood; his system is being drained of this essential to life and strength. What does he do? If he is sensible, he calls in a doctor, or perhaps several, in consultation; they ascertain the seat of the disease, and diagnose the cause. They point out that while consumption of blood is necessary for healthy life, it will lead to a premature end if the constantly increasing drain is not stopped. They suggest certain precautionary measures; and if he adopts them, he has a good chance of living at least as long as his contemporaries; if he neglects them, his days are numbered.

That is our condition as a nation. We have had our consultation in 1903; the doctors were the members of the Coal Commission. They showed the gravity of our case, but we have turned a deaf ear.

It is true that the self-interest of coal consumers is slowly leading them to adopt more economical means of turning coal into energy. But I have noticed and frequently publicly announced a fact which cannot but strike even the most unobservant. It is this: When trade is good, as it appears to

be at present, manufacturers are making money; they are overwhelmed with orders, and have no inclination to adopt economies which do not appear to them to be essential, and the introduction of which would take thought and time, and which would withdraw the attention of their employees from the chief object of the business—how to make the most of the present opportunities. Hence improvements are postponed. When bad times come, then there is no money to spend on improvements; they are again postponed until better times arrive.

What can be done?

I would answer: Do as other nations have done and are doing; take stock annually. The Americans have a permanent commission initiated by Mr. Roosevelt, consisting of three representatives from each state, the sole object of which is to keep abreast with the diminution of the stores of natural energy, and to take steps to lessen its rate. This is a non-political undertaking, and one worthy of being initiated by the ruler of a great country. If the example is followed here the question will become a national one.

Two courses are open to us; first, the *laissez-faire* plan of leaving to self-interested competition the combating of waste; or second, initiating legislation which, in the interest of the whole nation, will endeavor to lessen the squandering of our national resources. This legislation may be of two kinds: penal, that is, imposing a penalty on wasteful expenditure of energy-supplies; and helpful, that is, imparting information as to what can be done, advancing loans at an easy rate of interest to enable reforms to be carried out, and insisting on the greater prosperity which would result from the use of more efficient appliances.

This is not the place, nor is there the time, to enter into detail; the subject is a

complicated one, and it will demand the combined efforts of experts and legislators for a generation; but if it be not considered with the definite intention of immediate action, we shall be held up to the deserved execration of our not very remote descendants.

The two great principles which I have alluded to in an earlier part of this address must not, however, be lost sight of; they should guide all our efforts to use energy economically. Concentration of energy in the form of electric current at high potential makes it possible to convey it for long distances through thin and therefore comparatively inexpensive wires; and the economic coefficient of the conversion of mechanical into electrical, and of electrical into mechanical energy is a high one; the useless expenditure does not much exceed one twentieth part of the energy which can be utilized. These considerations would point to the conversion at the pit-mouth of the energy of the fuel into electrical energy, using as an intermediary, turbines, or preferably gas engines; and distributing the electrical energy to where it is wanted. The use of gas engines may, if desired, be accompanied by the production of half-distilled coal, a fuel which burns nearly without smoke, and one which is suitable for domestic fires, if it is found too difficult to displace them and to induce our population to adopt the more efficient and economical systems of domestic heating which are used in America and on the continent. The increasing use of gas for factory, metallurgical and chemical purposes points to the gradual concentration of works near the coal mines, in order that the laying-down of expensive piping may be avoided.

An invention which would enable us to convert the energy of coal directly into electrical energy would revolutionize our ideas and methods, yet it is not unthinkable. The nearest practical approach to

this is the Mond gas-battery, which, however, has not succeeded, owing to the imperfection of the machine.

In conclusion, I would put in a plea for the study of pure science, without regard to its applications. The discovery of radium and similar radioactive substances has widened the bounds of thought. While themselves, in all probability, incapable of industrial application, save in the domain of medicine, their study has shown us to what enormous advances in the concentration of energy it is permissible to look forward, with the hope of applying the knowledge thereby gained to the betterment of the whole human race. As charity begins at home, however, and as I am speaking to the *British Association for the Advancement of Science*, I would urge that our first duty is to strive for all which makes for the permanence of the British commonwealth, and which will enable us to transmit to our posterity a heritage not unworthy to be added to that which we have received from those who have gone before.

WILLIAM RAMSAY

THE FIRST UNIVERSAL RACES CONGRESS

THANKS to the indefatigable energy and enthusiasm of Mr. Gustav Spiller, who was ably assisted by Mrs. Spiller and supported by a large and representative committee, a new departure in the history of the world has been made by bringing together representatives of many classes of varied peoples to confer on the problems connected with the contact of races and peoples. During the week of the congress there could be seen in the halls of the University of London men and women of all shades of color and of different religions in friendly converse or planning schemes for breaking down racial and other prejudice, as well as for the betterment of mankind. For the majority it was a very serious occasion, as it is evident that they would not have come from such great distances at considerable expense and trouble if they had not thought it

worth while. From this point of view the sight was pathetic as well as inspiring. It is too early to form an opinion as to what the permanent result will be; at all events, many grievances have been laid bare, and those who were not too engrossed with their particular troubles or obsessed with their pet panacea will realize that there are very many difficult problems to face, the solution of which can only be made by calm thinking and long, patient work. Sentiment and rhetoric may initiate reforms, but their realization is mainly due to what may be termed mechanical methods.

A permanent result of the congress is to be found in the volume entitled "Inter-racial Problems" (Boston, The World's Peace Foundation, 29 A. Beacon St.), which contains some sixty articles specially written for the congress by more or less well-known people of diverse nationality. The authors had time to consider what they had to write and thus were able to give data and reasoned argument, as well as, in some cases, to formulate a constructive policy. The essays are naturally of unequal merit, but collectively they constitute an informing book on many social problems. Some of the speeches were also logical, sane and constructive, but their effect must necessarily be more transient, and the sultry weather combined with the poor acoustic properties of the hall further minimized their importance. No discussion was possible under the circumstances, each speaker was necessarily limited as to time, and many attempted to obviate this restriction by rapid utterance which really defeated their object. Even those who might have been expected to give data or argument may have felt that the conditions were unfavorable and so adopted a more rhetorical method. What has become of all the ideas that were promulgated? Unless there was an official stenographer the vast majority of them must have perished. No human being, even if he caught all that was said or understood the various languages that were spoken, could carry away more than a fraction of what he heard. A considerable number of patient souls seem to have sat

through everything; if they appreciated all that transpired their minds must have become very confused and their feelings painfully lacerated.

Without the least intention of being uncharitable, it appeared that a certain class wished to believe more than facts warrant. For example, because the anthropologists admitted that there was probably no race which would be described as pure, therefore races were chimerical; because skin-color is not of primary value in classifying peoples, the official program speaks of "so-called white and so-called colored peoples"; because the environment produces changes in certain physical characters (but to what extent, in what time, or how permanent they may be in modern times, we have practically no information) the classification of human varieties is a vain task. One anthropologist "swam against the current to the congress" by asserting that "the brotherhood of man is a good thing, but the struggle for life is a far better one." Another said he did not agree that all races were equal or that the differences were due solely to environment. It was not for the good of the world that all races should be equal, nor would they ever be, but it was desirable that all should have an equal chance of development. A third hoped that the ideas and ideals of various peoples would remain distinct and not merged into a common type of humanity. All agreed that there should be a sympathy based on mutual knowledge and forbearance among different nationalities. Taken from one point of view, much that was said by the anthropologists might be construed as supporting the views of a large number of the members of the congress, but the latter seem to have overlooked the very important element of time. Dr. C. S. Myres in his printed paper says: "If we assume, as I think we must assume, that the white and negro races owe their respective characters ultimately to their environment, there is no *a priori* reason, it seems to me, for denying the possibility of a reversal of their [mental and physical] differences, if the environment to which they are respectively exposed be

gradually, in the course of many hundreds of thousands of years, reversed." In some speeches often unmerited blame was bestowed on systems of government or on government officials without a due consideration of the special circumstances or the difficulties of the situation. What so many ardent spirits can not appreciate is that safe progress is slow progress and that compromises have to be made. Another fallacy was manifest in the belief that one system of government is suitable for all types of humanity. But most of the obvious defects were just those which were practically inevitable; the delegates and others were mainly those who came in response to strong emotion, and desired to draw attention to their own or their friends' grievances.

The social atmosphere was highly charged. They wanted things said in the hope of getting things done. Each fanned the flame of his own enthusiasm and that of others. There is no doubt that the congress has resulted in much friendliness between members of different nations, perhaps some misunderstandings have been removed, conscience has been stimulated, but the prosaic work remains to be done.

A. C. HADDON

THE MARINE BIOLOGICAL LABORATORY

THE investigators working at the Marine Biological Laboratory at Woods Hole, during a part or the whole of the season, have been as follows:

Abbott, James Francis, professor of zoology, Washington University, St. Louis.

Abbott, Margaret B., Bennett School, Millbrook, New York.

Addison, W. H. F., demonstrator of histology and embryology, University of Pennsylvania.

Allyn, Harriet M., fellow in zoology, University of Chicago.

Amberg, Samuel, associate professor of pediatrics, Johns Hopkins University.

Bancroft, Frank W., associate, Rockefeller Institute for Medical Research, New York City.

Bartelmez, George W., associate in anatomy, University of Chicago.

Beckwith, Cora J., instructor in biology, Vassar College.

Beutner, Reinhard, assistant, Rockefeller Institute for Medical Research.

Bradley, H. C., assistant professor of physiological chemistry, University of Wisconsin.

Browne, Ethel N., graduate student, Columbia University.

Budington, Robert A., associate professor of zoology, Oberlin College.

Calkins, Gary N., professor of protozoology, Columbia University.

Chambers, Robert, lecturer and laboratory assistant in zoology, University of Toronto.

Clapp, Cornelia M., professor of zoology, Mount Holyoke College.

Conklin, E. G., professor of zoology, Princeton University.

Craig, Wallace, professor of philosophy, University of Maine.

Curtis, W. C., professor of zoology, University of Missouri.

Davis, Sarah Ellen, 512 West 132d Street, New York City.

Derick, Carrie M., assistant professor of botany, McGill University.

Donaldson, H. H., professor of neurology, Wistar Institute of Anatomy and Biology, Philadelphia.

Dodds, Gideon S., instructor in zoology, University of Missouri.

Drew, Gilman A., assistant director, Marine Biological Laboratory.

Duggar, B. M., professor of plant physiology, Cornell University.

Dungay, Neil S., professor of biology, Carleton College, Northfield, Minn.

Dunn, Elizabeth H., instructor in anatomy, University of Chicago.

Eddy, Milton W., Northwestern University.

Ennis, Agnes, 453 Convent Avenue, New York City.

Ferguson, J. S., assistant professor of histology, Cornell University Medical School, New York City.

Fox, Henry, professor of biology, Ursinus College, Collegeville, Pa.

Glaser, O. C., assistant professor of zoology, University of Michigan.

Goldfarb, A. J., instructor in zoology, College of the City of New York.

Harvey, Basil C. H., assistant professor of anatomy, University of Chicago.

Harvey, E. Newton, Columbia University.

Hogue, Mary J.

Just, E. E., Howard University, Washington, D. C.

Kelley, Frank J., assistant in experimental breeding, University of Wisconsin.

Kellicott, William E., professor of biology, Goucher College.

Knower, H. McE., professor of anatomy, University of Cincinnati.

Knudson, Lewis, instructor in plant physiology, Cornell University.

Lefevre, George, professor of zoology, University of Missouri.

Lewis, Ivey F., professor of biology, Randolph-Macon College.

Lillie, Frank R., professor of embryology, University of Chicago.

Lillie, R. S., instructor in physiological zoology, University of Pennsylvania.

Loeb, Jacques, Rockefeller Institute for Medical Research, New York City.

Lyman, George R., assistant professor of botany, Dartmouth College.

Lyon, Mary B., instructor in zoology, Mount Holyoke College.

McClung, C. E., professor of zoology, University of Kansas.

Mackenzie, Mary D., associate professor of biology, Western College, Oxford, Ohio.

Mathews, Albert P., professor of physiological chemistry, University of Chicago.

Mathews, Samuel A., assistant professor of experimental therapeutics, University of Chicago.

Mayer, Alfred G., Carnegie Institution, Washington, D. C.

Meigs, E. B., fellow in physiology, Wistar Institute of Anatomy and Biology, Philadelphia.

Montgomery, T. H., Jr., professor of zoology, University of Pennsylvania.

Moore, George T., professor of botany, Washington University, St. Louis.

Morgan, T. H., professor of experimental zoology, Columbia University.

Morse, Max W., professor of biology, Trinity College, Hartford, Conn.

Newman, H. H., associate professor of zoology, University of Chicago.

Osterhout, W. J. V., assistant professor of botany, Harvard University.

Packard, Charles, assistant in zoology, Columbia University.

Paton, Stewart, lecturer in biology, Princeton University.

Patterson, J. T., adjunct professor of zoology, University of Texas.

Pike, Frank H., instructor in physiology, University of Chicago.

Quackenbush, L. S., 27 West 73d Street, New York City.

Rea, Paul M., professor of biology, College of Charleston.

Rogers, Charles G., professor of physiology, Syracuse University.

Scott, John W., Westport High School, Kansas City, Mo.

Sink, Emory W., assistant in zoology, University of Michigan.

Spaulding, E. G., assistant professor of philosophy, Princeton University.

Spencer, Henry J., graduate student, Columbia University.

Strong, O. S., instructor in anatomy, College of Physicians and Surgeons, New York City.

Tashiro, Shiro, student, University of Chicago.

Thomas, Mason B., professor of botany, Wabash College.

Wallace, Edith M., Columbia University.

Wasteney, Hardolph, assistant, Rockefeller Institute for Medical Research, New York City.

Whitney, David D., associate professor of zoology, Wesleyan University, Middletown, Conn.

Wieman, H. L., assistant professor of zoology, University of Cincinnati.

Wildman, E. E., professor of zoology, Central High School, Philadelphia, Pa.

Wilson, E. B., professor of zoology, Columbia University.

Woodruff, L. L., assistant professor of biology, Yale University.

THE UNIVERSITY OF TEXAS

At the annual meeting of the Alumni Association, held June 12, 1911, Mr. Will C. Hogg, of Houston, introduced the following resolutions, which were unanimously adopted by the Association:

Resolved, That the president of the University of Texas, Dr. S. E. Mezes, and the president of the Alumni Association, Mr. E. B. Parker, and such another gentleman as those two may select, be and are hereby appointed a committee of three to formulate and adopt for this association by-laws or rules defining the purpose of the organization of the permanent standing committee, and such by-laws and regulations adopted by the sub-committee of three herein authorized, are hereby adopted and made a part of this resolution as if read and carefully considered in advance at this meeting. Be it further

Resolved, That a committee composed of the presi-

dent of the University of Texas, the present president of the Alumni Association, the president of the board of regents of the University of Texas, are hereby instructed to proceed, in their own way, to the selection of a permanent standing committee of nine of ways and means for the enlargement, expansion, and extension of the University plan, and that the first meeting of said committee, if possible, be convened in the city of Austin on the first Saturday in October, 1911. Be it further

Resolved, That the President of the University of Texas, the present president of the Alumni Association of Texas and the president of the board of regents of the University of Texas be requested to select and authorize some suitable individual who will undertake, without any remuneration or expense, to provide a fund of not less than \$25,000 per year nor more than \$50,000 per year during the period of five years, payable in advance, in five equal annual installments of not less than \$25,000 per year nor more than \$50,000 per year, on the first day of October, 1911, 1912, 1913, 1914 and 1915.

The objects of these resolutions are described as follows:

1. To stimulate thought and create and arouse aspiration for higher education in Texas.

2. To attract the best thought and attention of aspiring persons engaged in educational work throughout the United States and Europe.

3. To inform the people of Texas that the organization, through the committees, is going to investigate, deliberate upon and advise the people of Texas what the extent of the physical institution should be, and what adequate means of maintenance should be provided. This is the restricted office and purpose of the organization which will be accomplished by the application of modern business and scientific methods of inquiry, investigation and determination.

4. The conception and definition of a curriculum, thorough-going and modern in all its details, comprehending the various activities of a modern commonwealth organization.

The following awards are proposed:

1. The award of a cash prize of \$10,000 or more to architects for the best landscape and

building design which will be the physical expression of the state's aspiration for higher education, and a second prize or prizes of \$5,000 or more for the best thesis or theses on a properly assigned subject involved in the general educational design. It is probable that the competition in these classes will be limited to architects and professional educators of high reputation and that it will be closed for entry on or before January 1, 1913, all designs and theses to be filed on or before January 1, 1914. It is intended that such competitors shall have at least two years during which to prepare their designs and theses in this competition.

2. An annual prize of \$500 or more for the best thesis on a selected and assigned topic involved in the general design of the movement, competition to be limited to graduating students of the University of Texas, awards to be made in October each year of the five-year period.

3. An annual prize of \$500 or more, in the discretion of the committee, for the best thesis on a duly assigned topic involved in the general design, the competition to be limited to citizens of Texas other than graduating students of the university, awards to be made in October each year of the five-year period.

4. An annual prize of \$500 or more for the best thesis on an assigned subject involved in the general design of the movement, the competition to be limited to graduating students of ten accredited universities of other states of the United States, of two colleges in Canada, of two in England, of one in Scotland, of two in Germany and of one in France.

SCIENTIFIC NOTES AND NEWS

THE Astronomical and Astrophysical Society of America met at Ottawa, Canada, from August 23 to 25. The officers elected are: E. C. Pickering, *president*; E. B. Frost, *first vice-president*; W. W. Campbell, *second vice-president*; W. J. Hussey, *secretary*; C. L. Doolittle, *treasurer*; J. S. Plaskett and W. S. Eichelberger, *councillors*. The next annual meeting will be held at Allegheny Observatory in August, 1912. The society will also meet

at Washington in December, in connection with the meeting of the American Association for the Advancement of Science.

THE annual Herter lectures will be delivered at the Johns Hopkins University on October 4, 5 and 6, by Professor Dr. Albrecht Kossel, of the University of Heidelberg, who was awarded the Nobel prize last year for his discoveries in medical chemistry.

THE German emperor has conferred on Sir William Ramsay the order "Pour le Mérite."

DR. JACQUES LOEB, of the Rockefeller Institute for Medical Research, has been elected a member of the Academy of Science in Cracow. Dr. Loeb has sailed for Europe to make an address before the Congress of Monists to be held in Hamburg.

At the July meeting of the Spanish Society of Physics and Chemistry of Madrid, Professor Alexander Smith, of Columbia University, was elected an honorary member of the society.

At its last commencement, the State University of Iowa bestowed the degree of doctor of laws on Professor William H. Norton, professor of geology, Cornell College, Iowa.

PROFESSOR JOHN B. EKELEY, head of the department of chemistry at the University of Colorado, was recently appointed state chemist by the state board of health. In June the honorary degree of doctor of science was conferred on him by his alma mater, Colgate University.

MR. D. E. HUTCHINS, chief conservator of forests, British East Africa, after ten years' forest service in India, twenty-three in South Africa and four in equatorial Africa, has retired on a pension.

R. H. BAKER, Ph.D. (Pittsburgh, 1910), has been appointed director of the Laws Observatory, University of Missouri.

DR. JAMES R. WEIR, Ph.D. (Munich), has been appointed an expert in forest pathology in the Bureau of Plant Industry.

MR. J. ALLAN THOMSON has been appointed paleontologist to the Geological Survey of New Zealand.

DR. N. L. BRITTON and Mrs. Britton are for a month at the Royal Gardens, Kew, England, in continuation of their studies on the flora of the West Indies.

MR. S. H. BURBURY, F.R.S., distinguished by his work in mathematical physics, died on August 18, at eighty years of age.

NEXT year the American Geographical Society celebrates its jubilee, and in connection with this event a transcontinental excursion for the purpose of geographical study is planned, under the leadership of Professor W. M. Davis. The start from New York, by special train, will take place some time in August, and the excursion will conclude in October, its duration being six or seven weeks.

THE South Australian Cabinet has decided to contribute £5,000 towards the cost of the Mawson Antarctic Expedition.

LETTERS have been received from Messrs. Vilhjalmur Stefansson and Rudolph M. Anderson, the Arctic explorers sent out three years ago by the American Museum of Natural History. A letter from Mr. Stefansson tells of the hazardous journey he undertook east from Cape Parry to the Coppermine River region, as far as Coronation Gulf. He discovered a tribe of Eskimos with fair complexions, white hair and red beards—these may be, he thinks, the descendants of the lost Scandinavians, who disappeared several centuries ago. He found also a primitive people, using stone implements, who could not count above five, and wiped from the map the Le Ronciere River. A letter from Mr. Anderson records his observations, chiefly of Arctic birds and animals, on his trip westward to Langton Bay.

At the 1909 meeting of the International Mathematical Congress, held at Rome, the subject of mathematical teaching was brought forward, as *Nature* reminds us, and upon the initiative of Professor D. E. Smith, U.S.A., it was decided to form an International Commission on the Teaching of Mathematics, this commission to report to the next triennial meeting of the congress, which will be held at Cambridge (England) in 1912. The commis-

sion will meet at Milan on September 18-20 of this year to take stock of the work done so far.

THE first all-Russian congress of women of academic education will be held in November of this year in St. Petersburg.

THE U. S. Public Health and Marine-Hospital Service has just issued a series of nine wall charts illustrating the anatomy and life-history of hookworms, the methods of their dissemination, methods of prevention and pictures of severely infected patients. These charts are intended for use in schools, colleges and in field work. They are now being used by some of the state boards of health in the campaign for the eradication of hookworm disease. The charts are printed on heavy paper mounted on linen with wooden hangers and are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C.

THE State Geological Survey of Colorado, of which Professor Russell D. George, of the state university, is head, has three main parties in the field this summer. The first party, consisting of seven men, is under the direction of Assistant Professor Ralph D. Crawford, of the university. It is extending work begun in 1909 in the Monarch and Garfield area of Chaffee County to adjacent parts of Gunnison County. Professor Horace B. Patton, of the State School of Mines, heads a party at work about Alma, near Leadville. Under the direction of Professor F. F. Grout, of the University of Minnesota, a third party is doing rapid reconnaissance work in the Rabbit Ear Range in Routt and Grand counties. A study of the mineral and hot springs of the state is another activity of the survey. Mr. Roy M. Butters, of the university, and Mr. Frank Slattery, of the School of Mines, are visiting all the important springs.

For the first time the coal mines of the United States in 1910 were credited with an output exceeding half a billion short tons, the combined production of anthracite, bituminous coal and lignite having amounted to 501,576,895 short tons. This great output was attained in spite of the fact that most of the

mines in Illinois, Missouri, Kansas, Arkansas and Oklahoma were closed for nearly six months by one of the most bitterly contested strikes in the history of the industry. The heaviest tonnage mined in any year previous to 1910 was in 1907, when a total of 480,363,424 short tons was produced.

OF the nineteen mines producing quicksilver in the United States in 1910, fifteen are located in California, two in Nevada and two in Texas, according to H. D. McCaskey, of the United States Geological Survey. The production in 1910, as obtained from confidential returns to the Geological Survey by every producer in the country, was 20,601 flasks of 75 pounds each. At the average domestic price at San Francisco, \$46.51 a flask, the value was \$958,153. As compared with the production of 1909, which was 21,075 flasks, valued at \$957,859, this shows a decrease in quantity of 474 flasks but an increase in value of \$294. Although the production of California increased in 1910, the output from Oregon decreased to nothing, as that of Arizona did in 1909, the small Nevada production fell off considerably, and the output from Texas decreased. In no state, except possibly Nevada, can an increased output be expected for 1911, the present outlook being for a total production for the United States not exceeding 20,000 flasks. A good domestic demand for quicksilver was noted throughout 1910. The principal uses are for gold milling and placer mining, for the manufacture of vermilion, fulminates, physical instruments, and drugs, and for lighting. The use of quicksilver in making the fulminate of percussion caps for igniting powder is increasing in importance probably more than any other use. The imports of quicksilver for domestic use are now nominal, having been in 1910 only 667 pounds, valued at \$381, although the values of the imports in the preceding three years varied from \$6,000 to \$8,000. The exports of quicksilver in 1910 were 144,237 pounds, valued at \$91,077, against 510,141 pounds, valued at \$266,243, in 1909. The chief market is now Canada, followed by Mexico. The world's production of quicksilver in 1910 was 3,399

metric tons of 2,204.6 pounds each, against 3,304 tons in 1909, 3,296 tons in 1908 and 3,307 tons in 1907. Spain is the largest producer, furnishing nearly a third of the total world's supply from the famous Almaden mines. The United States, Austria-Hungary and Italy have in turn held second place, this country ranking third in 1910.

THE *Geographical Journal* states that Mr. Egon F. Kirschstein—a Russian by birth though living in Berlin—who accompanied the Duke of Mecklenburg on his journey across Africa in 1907-08, and did good work there by his investigation of the Virunga volcanoes, is about to undertake a new expedition to Central Africa, this time on his own account. His route will be through Portuguese East Africa to Lake Nyasa, and thence to Tanganyika and northwards along the frontier of the Belgian Congo to the Nile, thus touching in part his old area of investigation near Lake Kivu. The duration of the new expedition will probably be between one and two years. A considerable stay will be made in the district between Lakes Nyasa and Tanganyika, which it is proposed to traverse in all directions. Among other items, the ascent and geological investigation of the little-known Konde volcanoes near Lake Nyasa, as well as a visit to the Rukwa valley, are planned. The scientific collections are destined for the museums in Berlin, Brussels and St. Petersburg.

THE *Journal* of the American Medical Association supplies the following figures regarding the number of medical college graduates in the United States.

Year	Regular	Homeo- pathic	Electric	Physio- Med.	Nonde- script	Total
1880	2,673	380	188	3,241
1890	3,853	380	221	4,454
1900	4,715	413	86	5,214
1901	4,879	387	148	18	12	5,444
1902	4,508	336	138	16	11	5,009
1903	5,088	420	149	24	17	5,698
1904	5,190	371	146	20	20	5,747
1905	5,126	276	153	22	23	5,600
1906	4,841	286	186	22	29	5,364
1907	4,591	225	121	11	32	4,980
1908	4,370	215	116	12	28	4,741
1909	4,163	209	84	15	44	4,515
1910	4,113	183	114	16	14	4,440
1911	4,006	152	110	5	...	4,273

CAPTAIN PÉRIQUET has returned to France after completing his surveys in French Equatorial Africa along the line of a possible railway from the coast to the interior. According to the *Geographical Journal* he professes himself convinced of the value and feasibility of such a line, which would tap a rich region of virgin forest abounding in rubber-yielding plants. Besides fixing fifty-four new positions, Captain Périquet and his coadjutors carried out route-surveys totalling some 3,000 miles, paying much attention also to the determination of levels. The traveler was much impressed by the intelligence and general character of the western Pahuins (Fans), who are said to be the most interesting people of the territory, fully equalling the Senegalese in their adaptability to civilization.

THE U. S. Geological Survey has made public figures prepared by Mr. J. P. Dunlop, showing the recovery of "secondary" copper, lead, zinc, tin and antimony in 1910. The total amount of secondary copper recovered, on the assumption that the brass remelted had an average copper content of 70 per cent., was 91,500 tons, of which 15,500 tons was recovered by regular refining plants and the remainder by plants treating only secondary material. At least 30,000 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that only 61,500 tons was obtained from ashes and cinders and from material that had entered the trade in manufactured form and been discarded. The survey inquiry was extended so as to include the railway companies' figures for old metals reused by themselves, and to these is attributed a large proportion of the increase in the figures for copper. The production from secondary sources in 1910 was equal to about 17 per cent. of the domestic consumption of new copper. The secondary lead was equal to 11.5 per cent. of the refined lead produced in the United States. The secondary zinc equaled 23.2 per cent. of the total production of primary spelter in the United States. The secondary antimony shows a large increase, and, as the production from domestic antimonial and antimonial lead ores

was comparatively small, the secondary recoveries are the only important domestic source of supply. The production of tin from ore mined in the United States is negligible, so that the secondary recoveries constitute practically the sole domestic supply. The use of old tin cans as a source of tin was not extended. The cost of collecting, transportation charges and inability to dispose of the old black plate from which the tin is wholly or partly removed are the principal reasons given why more old tin cans are not utilized.

UNIVERSITY AND EDUCATIONAL NEWS

THE daily papers state that there will be established at Ragland, Ala., an industrial school for white children by the Southern Board of Education with funds amounting to \$5,000,000 to be given by Mr. John D. Rockefeller, the Russell Sage Foundation, Mrs. E. H. Harriman and others. Ragland offered 5,000 acres for the site, 200 lots in town, water power and other considerations.

DR. S. N. KOLACEOSKI, who died recently, bequeathed all his property, estimated at 40,000,000 rubles, for the establishment, in southern Russia, of an agricultural academy.

CONCRETE foundations have been completed for Rand Hall, the new Sibley shop building, of Cornell University, and steel for the framework is arriving on the premises.

As previously announced, the inauguration of Dr. Guy Potter Benton as president of the University of Vermont will take place on the fifth and sixth of October. Following the general plan already given, the formal inauguration exercises will take place on the second day. The first day will be given to a conference between colleges and secondary schools on the subject, "College Requirements and the Secondary Curriculum."

CARBON GILLASPIE, M.D. (Colorado), has been appointed professor of anatomy in the University of Colorado. Since 1909 Dr. Gillaspie has been instructor in this department. He will give all his time to teaching.

MR. WILLIAM J. MCCAUGHEY, mineralogist and petrographer of the U. S. Bureau of Soils,

has been appointed as assistant professor in metallurgy and mineralogy in the Ohio State University.

P. F. GAEHR, Ph.D. (Cornell), formerly of Robert College, Constantinople, has been appointed professor of physics at Wells College, Aurora, N. Y.

ADDITIONS to the faculty of the Agricultural College of Utah for the year 1911-12 are as follows: E. G. Titus, Sc.D. (Harvard), professor of entomology; F. L. West, Ph.D. (Chicago), professor of physics; Elmer G. Peterson, A.M., Ph.D. (Cornell), professor of bacteriology; F. S. Harris, Ph.D. (Cornell), professor of agronomy; C. N. Jensen, M.S.A. (Cornell), professor of botany and plant pathology; J. E. Greaves, Ph.D. (California), associate professor of chemistry; and W. E. Carroll, M.S. (Illinois), assistant professor of animal husbandry. J. C. Hogenson has been transferred from college work to the extension division as agronomist. The extension division has been enlarged further by employing Miss Hazel Love Dunford for work in home economics.

DR. A. N. WHITEHEAD, F.R.S., fellow of Trinity College, Cambridge, has been appointed to succeed Mr. E. Cunningham, as lecturer in the department of applied mathematics and mechanics in the University College, London.

DISCUSSION AND CORRESPONDENCE

MOISTURE AND OUT-OF-DOORS

TO THE EDITOR OF SCIENCE: This being the dearest time of the year, when nobody reads SCIENCE, and the post-office refuses to send it after one, I am emboldened to take my pen in hand. The two very clear letters by Messrs. Mott-Smith and Wilson, in answer to Dr. L. H. Gulick's query regarding moisture in the air, together with those of Messrs. Kent, Crowell and Jones in the issue of March 31, leave little or nothing to be said on the subject. What I wish to emphasize is the feeling of shock that I experienced when a medical man of the standing of Dr. Gulick could ask such questions in good faith, when, as has been said, the answers to them can be

found in any treatise on physics. Taking the one which happens to be nearest my hand, that of Magie, I find the subject treated completely in four pages. The point I wish to make is that these matters are taught in freshman courses. But who takes these courses? There is the rub. Of course we know that all engineering students are compelled to take courses in physics. We also know that most chemists take them. Some now even take courses in mathematics, and when a chemist gets a control of mathematics, we know how he makes mathematics hum! One would expect that every medical student would be required to take a course in physics. In other countries this is so. I remember how the elementary courses of Helmholtz and Kundt were so choked up with "Mediziner" as to cause them to grumble. But I fancy that in this country things are here as elsewhere, somewhat at loose ends. A few years ago I remember hearing an address by Dr. Welch on the relations of medicine to physics, so clear, so luminous, so interesting, so learned that it seemed to me that no other medical man in the country could have given it, and I thought, fortunate is the medical-school that has such a teacher! But why should not everybody desiring to be liberally educated study physics? I do not stop to give the reasons, everybody that is liberally educated knows them. And yet we see chemists, psychologists, physiologists, microscopists and many others, every one of whose tools is physical, ignorant of this fundamental science and its methods, and the intelligent man in the street is asking whether the drought is due to the great increase of electric railroads! And how many of our colleges require everybody to take a course in physics? I can not answer this definitely, but I know of only one, Princeton, and I will say to the honor of that institution that I was told that this was the only subject on which the faculty was unanimous.

But Dr. Gulick's letter is on a very important subject, on which an enormous amount depends, and on which little seems to be known. The question is, briefly, what is the advantage of out-doors over in-doors? All I

can contribute to this is a little scientific common-sense. If it is due to the air, as seems implied by most writers, what properties has the air? These can be of only three kinds: first, physical; second, chemical; third, biological. The physical properties are very simple and easily investigated. They are its temperature, pressure and density, and the density of water vapor in it. To these I venture to add its ionization. No discussion is now complete without some mention of ions, so put that in. Do not forget the sunlight. The chemical aspect is simple and consists only in the knowledge of the amounts of the various gases present. Finally, there is the question of what and how many microorganisms are present. This, the most difficult and perhaps the most important of all, we may turn over to the biologist. Dr. Gulick, who says that he has digested all the literature found in the bibliographies, says that "we know definitely" that there is no such thing as a subtle human poison (anthropotoxin) which varies in proportion to the CO_2 . Very well, but, to use the vernacular, "they tell me different."

As an illustration of what I have said, consider what happens when a man smoking a cigar comes into my neighborhood. The first impression that I get is a sense of filth (stink is what the Bible says). This is psychological, and I will not go into it. Then I realize that the chemical equilibrium of the atmosphere has been destroyed, and that a foreign physical body has been introduced, though whether the pressure of the air has been altered I can not say. Also whether there is an anthropotoxin present I can only query, although I know one *anthropos* that is immediately toxized.

Now for the question, what *is* out-doors? Obviously the question of doors and walls is not the main thing. We know that, *ceteris paribus*, the same effects will follow. The only question is as to what "*ceteris*" are "*paribus*." Does any one doubt that, if the air is physically, chemically and biologically (microorganisms) the same indoors and out, the physiological effects will be the same?

Why, the thing has never been tried! In the name of suffering humanity, let us try it, in the manner suggested by Professor Kent. I have not the slightest doubt that the superiority of out-doors for the health is due to the fact that it is impossible in-doors to secure the circulation of the air that will continually remove the noxious products and replace the air with absolutely good air. Again look at the smoker. It is with difficulty that you can get him to smoke in the open air. It takes away his filthy chemical, and he will often admit to you that at night, and out-of-doors, he can not tell whether he is smoking or not. Thus he gives his whole case away, and helps me in my argument.

There is one other thing that we must not overlook, and that is the sun. I dare say that in spite of all we might do to the air, if we did not pass it out into the sun we should not accomplish much. What does the sun do to the air? Photochemistry will have to answer this, and it soon will. And finally remember that the conditions of radiation of heat from our bodies are totally different when we are surrounded by walls and when not. The question of out-doors is, accordingly, not a simple one, but is composed of simple parts. Let us attack it in detail. Perhaps it will be answered before the other equally important one, *Shall we wash?* And this reminds me of a passage in Dr. Gulick's letter which I can not let pass. In a well ventilated school-room (in London) there was "no smell of human beings—this was only noticeable when one stood among the *boys*" (*italics mine*). As an ex-boy I resent this.¹

Finally let me suggest an answer to Mr. Mott-Smith's last question: "Why is a little sneaking draught in the house a source of colds and grippe, while a high wind out-of-doors a pleasure and a benefit?" I suspect that the answer will be Mr. Dooley's consoling one to Hennessey, "It ain't so!"

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,

August 4, 1911

¹ It has occurred to me that perhaps it was a boys' school.

ELECTRONS

TO THE EDITOR OF SCIENCE: Will you permit an old foggy to trespass on your space long enough to ask a simple question? I confess that in spite of bibliographies, card catalogues, scientific management and all the helps to the weary, I have lately found it impossible to keep up, and find myself confronted with the horrid thought of having to become a specialist. I have not even been able to read all that the chemists have written about physics. Now whether we agree with what has recently been said by a notorious chemist (perhaps I mean noted, but the weather is so hot) that "we appreciate fully that physics, geology, engineering, physiology, medicine, botany, zoology and biology (why not astronomy?) are subdivisions of the broader science of chemistry, we see that the chemist of the future must know a great deal more than any of us do now"—whether we agree with this poet or not (and I cordially agree with his final statement) we know that in future the physicist has got to sit at the feet of the chemist (I hope he will sit *on* them). But in Professor McCoy's very interesting article on metals I find the following statement, which causes me some difficulty: "The charge of the electron is negative in sign. In fact we have decisive experimental evidence of only this one kind of free electricity, positive electrification of a body being from this standpoint merely a deficiency of electrons. J. J. Thomson has shown how from the conception of an atom made up of electrons rotating in a sphere of positive electrification, there follows," etc. Now I submit that logically the above statement would be helped by a substitution in the last sentence of the definition from the next to the last, so as to read: "an atom made up of electrons rotating in a sphere of merely a deficiency of electrons," etc. What I want to know is, what is this spherical deficiency made of? Is it a hole in a space all full of electrons? If so, what about the lonely electrons rotating in this hole in the whole body of electrons? But perhaps

I have not got it right. This is hot weather anyhow. I presume the passage in "quotes" is from some of Sir J. J. Thomson's writings. I do not want Dr. McCoy to think that I am blaming him. But if so, what are all these papers of Thomson's and Wien's on positive rays about? Being an old foggy, I sometimes feel that there are too many electrons about, and that one of the wonderful fly-traps that you read so much about in the papers ought to be devised to catch them. I remember (dimly) that when I was a boy in college I had a great aversion to molecules. I had never seen one, and didn't like them. And now I have the same queer feeling about electrons. But perhaps I shall see one some day. Rutherford has. But the one he saw was positive. Wasn't it? I am not positive.

Speaking of chemists, I think the best joke ever made by a chemist was when Mendelejeff undertook to consider the ether as a chemical element! Why not have the ether made of electrons? To which of these hypotheses should we incline? I answer in the words of Dr. Holmes, "To ether."

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,

August 4, 1911

THE SCIENCE OF GOVERNMENT

TO THE EDITOR OF SCIENCE: Investigations are the order of the day, not only by scientific men, but (save the mark) by Congress. Your quotation from the *Independent* with regard to Dr. Wiley encourages me to express the hope that this incident may lead to an investigation (by both classes of persons) of the whole question of the relation of the government to science. Every interest in the country that has votes enough and can log-roll enough support is looked after by the government, and eventually gets a cabinet officer, why not science? I suppose there is no doubt that our government spends more on science than any other. I suppose there is equally no doubt that it gets less for its money than any other, and that there are many abuses unworthy of a civilized régime which ought to be abolished. Of these the chief one is, why are not scientific

affairs managed by scientific men? I suppose it is because members of congress do not believe that scientific men are worth more than \$9 a day. As long as scientific men are willing to tolerate such an assumption I do not much blame the congressmen.

But there is another reason, hinted at in your quotation. It is that the atmosphere of Washington is not only rotten (I have treated the atmosphere elsewhere) for science, but it is infested with a most dangerous parasite, the *red-tape-worm*, I do not rightly know whether to call it a protozoan, a microtome, or a cyto-blast, but either Dr. Charles Hookworm Stiles or Dr. L. Culex Howard can tell. This worm eats the vitals out of the scientist, and leads him to pretend that he didn't do the research, but that the man higher up did. Washington is a charming city, full of statues of men on horseback, waving cocked hats, but when every scientist has to have an assimilated rank, so that he shall know whether he is a captain or a major-general, the results can only be painful. I am glad that I did not coin the phrase, "Washington Science," and equally glad that some one else did. By the way, not all Washington science is done under the government. I hope this letter may provoke discussion, but I do not wish to take part in it. Like all brave anarchists, I wish merely to explode the bomb, and then run like . . . !

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,

August 4, 1911

DUE—

TO THE EDITOR OF SCIENCE: Due to the death of my imaginary stenographer, I am able to write you but a few lines. This is a quotation from any one of several hundred scientific contributions that I have read lately. The object of my writing now, Mr. Editor, is to ask of you (for the first time) a favor, and that is that you will refuse to print any communication in which the adjective "due" appears in any way except as agreeing (I think that is the word) with some noun or pronoun. As I believe that one who does not do research himself may do good by suggesting subjects

to others I suggest this. "Which is the worse, the English of scientists or of politicians?" Will and shall barred.

ARTHUR GORDON WEBSTER

WORCESTER, MASS.,

August 4, 1911

SCIENTIFIC BOOKS

A History of the Theories of Æther and Electricity from the Age of Descartes to the Close of the Nineteenth Century. By E. T. WHITTAKER. London, Longmans, Green & Co.; Dublin, Hodges, Figgis & Co., Ltd. 1910. Pp. xiv + 475.

In this excellent volume, the Royal Astronomer of Ireland traces the development of our ideas concerning the nature of the ether and of electricity, as expressed by the various theories which have been proposed from time to time about these entities.

The treatment includes an account of those discoveries in light, electricity and magnetism which have been influential in shaping and supporting theory, and these facts are interwoven with the discussion of the theories themselves in such a way that a historically continuous narrative results. Everything is made subservient, however, to the explanation of the theories themselves. These are discussed at sufficient length to bring out their chief features, and often too their limitations are noted. The discussions are not confined to verbal description, but preference is given rather to a deeper treatment from the mathematical side. The book is intended, therefore, mainly for the advanced student who alone is in a position to go into the details of the subject.

The work opens with a chapter on the theory of the ether in the seventeenth century, covering a period in which the wave theory of light had but begun to receive attention. The next two chapters deal with the fundamental discoveries in electrostatics and about steady currents in conductors, and with the earlier electrical theories. Then come two chapters on the ether in that period when the wave theory of light had its greatest development, although light was still not associated with electrical action.

The following five chapters, beginning with one on Faraday, cover a half century in which attention was directed more and more upon the action in the dielectric surrounding a conductor, which finally resulted in the electromagnetic theory of light. The two closing chapters deal chiefly with the rise of the theory of electrons and the part they play in optical and electrical phenomena.

The book will be welcomed by all physicists as a valuable contribution. J. Z.

The Social Direction of Human Evolution:

An outline of the science of Eugenics. By WILLIAM E. KELLICOTT. New York, D. Appleton & Company. 1911.

William Morris once said that a cause, in winning its way to acceptance, had to pass through three stages: first, all men ignored it; second, all men opposed it; third, all men accepted it. The cause of eugenics has survived the first stage without really entering upon the second. It even seems possible that it may contrive to skip a considerable part of the second stage of the metamorphosis, and enter into its heritage with little opposition. It is much too early, however, to confidently predict anything of the sort, and it may be necessary to go through troublous times, if only to arrest the attention of an easy-going and unscientific public.

Just now, the time is not ripe for an extended work on eugenics, but, on the other hand, the moment is opportune for the appearance of a little book such as that of Professor Kellicott. Not long ago, Dr. C. B. Davenport issued a very convenient little pamphlet, which has been widely read. Professor Kellicott's book is larger, but has a similar aim, both being admittedly ephemeral works intended to inform the general public. Now that interest has been aroused in several quarters, and important investigations bearing upon the subject are being made, a new book, or a new edition of an old one, will be needed perhaps nearly every year for some time to come. The volume before us will excellently serve present needs, and perhaps as the necessity arises its author will prepare

other editions, keeping it abreast with the times. From the brevity of the treatment and the propagandist aim, it results that the statements given are in some cases rather more confident or dogmatic than the facts known to us may warrant. In particular, I should have wished to look a little more cautiously over some of Karl Pearson's results, such as those on the inheritance of mental traits and on the greater susceptibility to disease of the first born in a family. Broadly speaking, however, the arguments are sound and well presented, and any non-scientific person reading and accepting them as they stand will not go far astray.

The first chapter, on "the sources and aims of the science of eugenics" begins with a summary of the history of the subject, and goes on to discuss the relations of biology to sociology, giving some of the sociological data which are important for the "eugenist." The second goes into the biological foundations of eugenics, and gives a condensed account of the main facts concerning variation, heredity and kindred matters. In the description of the Mendelian phenomena, the first case given is one (the Andalusian fowl) in which the heterozygous form is unlike either of the homozygous ones. This reverses the usual order, with I think distinct advantage, making the matter clearer and showing from the start that dominance is not essential to Mendelism. The third and final chapter is a long one on human heredity and the eugenic program. In it are given many striking human pedigrees, and much other information likely to astonish many readers. On page 200, in discussing the inheritance of acquired characters, the "giraffe's neck and the fox's cunning" are classed among these, by some slip or ambiguity. In connection with this matter we may perhaps question the practical limitation of the concern of the eugenist (pp. 42-43) to "conditions which affect the innate characteristics of the race," as it is obvious that improved social conditions will tend to bring out or make visible desirable innate qualities, which may then be considered successfully from the standpoint of eugenics.

The author rightly insists that a large part of the present eugenic program is educational. Scientific men who are of this opinion can do something for the cause if they will help to circulate Professor Kellicott's book.

T. D. A. COCKERELL

Animal Intelligence. By Professor E. L. THORNDIKE, Columbia University. New York, The Macmillan Co. 1911. Pp. viii + 297. \$1.60 net.

Students of behavior, biologists and experimental psychologists, alike, welcome the volume containing the collected papers on animal psychology of Professor E. L. Thorndike which has just been published in the Animal Behavior Series.

For some years the most important two of the papers, "Animal Intelligence" and "The Mental Life of Monkeys," published originally as Monograph Supplements to the *Psychological Review*, have been out of print. Since Thorndike's studies marked the dawn of the experimental era in animal psychology it is distinctly worth while to have this material in convenient form and available for students for years to come. The historical value of the work, however, is not the chief reason for the publication of the volume. However much the technique and scope of animal psychology may have advanced since the first appearance of Thorndike's work, his penetrating discussions of the general nature of animal mind have by no means been outgrown. In looking back upon his work one is struck by the boldness and apparent rashness of his general conclusions, especially in view of the fact that his experimental material was limited; and yet those conclusions in the most essential points have stood the test of twelve active years.

J. B. WATSON

QUOTATIONS

SEVEN YEARS' PROGRESS IN MEDICAL EDUCATION

THOSE who have been watching the development of medical education in this country have noted with no little astonishment and gratification the remarkable progress that has been made in recent years and particularly

since the American Medical Association created its permanent committee, the Council on Medical Education. At the beginning of its work in 1905, after a thorough investigation of conditions the council formulated two standards of medical education, one for immediate adoption and an ideal standard for future consideration. These standards were not for any one state or for any one section, but for the entire country. The result is that nearly all colleges are up to or beyond the standard recommended in 1905 for "immediate adoption," while more than a third of the colleges (42) have, so far as entrance requirements are concerned, adopted the "ideal," namely, a four-year high school education, plus at least one year to include thorough courses in physics, chemistry, biology and modern languages.

During 1906 and 1907, the council made the first complete personal tour of inspection of the medical colleges of the United States that had ever been made, and in 1907, reported its findings at its annual conference and to the House of Delegates of the American Medical Association. This inspection revealed the fact that nearly a third of the medical schools existing at that time were seriously defective in their methods, standards and equipment. Since that report was made the decrease in the number of these inferior colleges has been marked, while, on the other hand, there has begun a corresponding improvement in many other colleges. The second inspection was completed in 1910, and resulted in the publication of a classified list of medical colleges. This doubtless gave added impetus to the improvements being made and to the further elimination of unworthy colleges. In seven years, therefore, the over-supply of medical schools has been reduced in number, quantity giving way to quality, and a decided check has been placed on the rapid multiplication of inferior schools.

In 1908 and 1909, a thorough study of the medical college curriculum was made by a special committee of the council, made up of over a hundred leading medical educators, to ascertain the relative value of the subjects of the curriculum in order that proper emphasis

might be laid on them in the medical course. This special study also included the character of equipment, methods of instruction, qualifications of teachers, necessary hospital facilities, etc. As a result of this and the council's reports based on its actual inspection, an unprecedented improvement in the physical equipment and methods of medical education was started. New college buildings have been erected; more teaching hospitals have been secured; new laboratories have been equipped and more expert full-time teachers employed.

During each of the seven years the council has held a special, delegated conference attended largely by members of state licensing boards, university presidents, representatives of medical colleges and other prominent educators. These conferences have had a wide and powerful influence in the progress that has been made. They have resulted in more uniformity of effort on the part of all forces working for the betterment of educational standards and have provided opportunity for the study and discussion of educational problems. Above all, however, at these conferences, the attention of university presidents and others has been drawn to the absolute necessity of state aid or private endowment for medical schools. As a direct or indirect result of this campaign, the amount of money given for medical education has increased from a few thousands of dollars during 1904 to several millions of dollars during the last year. This is indeed encouraging and gives promise of even greater advancement in the immediate future.

Of course, not all the credit for these vast improvements belongs to the Council on Medical Education. Nevertheless this body, representing the organized profession of the country and holding up standards of national and not sectional scope, was bound to have a powerful influence. It has cooperated with the other agencies which have been doing masterly work in their various fields, and has brought about greater harmony and more unanimity of effort. These achievements are the more gratifying since all the agencies save one, the Carnegie Foundation for the Advancement of

Teaching, are entirely made up of physicians and fully represent the medical profession. Meanwhile, no one is better acquainted with the needs of the people in regard to the prevention and cure of disease and the preservation of health and healthful conditions than the medical profession itself. And that the medical profession may be even more capable of caring for these needs, nothing is more important than the continued improvement of medical education.—*Journal of the American Medical Association*.

SCIENTIFIC JOURNALS AND ARTICLES

THE contents of the *Journal* of the Washington Academy of Sciences for August are as follows:

Physics.—“Melting Temperatures of Sodium and Lithium Metasilicates,” F. M. Jaeger.

“A Method for Determining the Density of certain Solids by means of Rohrbach’s Solution having a Standard Refractive Index,” H. E. Merwin.

Electricity.—“A Study of the Current Transformer with Particular Reference to Iron Loss,” P. G. Agnew.

Geochemistry.—“Minerals and Rocks of the Composition $MgSiO_3$ — $CaSiO_3$ — $FeSiO_3$,” Robert B. Sosman.

Mineralogy.—“Crystallized Turquoise from Virginia,” Waldemar T. Schaller.

“Quartz and Fluorite as Standards of Density and Refractive Index,” H. E. Merwin.

“The Temperature Stability Ranges, Density, Chemical Composition and Optical and Crystallographic Properties of the Alkali Feldspars,” H. E. Merwin.

Petrology.—“A Micrometer Ocular with Coordinate Scale,” Fred Eugene Wright.

“The Lavas of Hawaii and their Relations,” Whitman Cross.

Paleontology.—“Remarks on the Fossil Turtles Accredited to the Judith River Formation,” F. H. Knowlton.

Zoology.—“Remarks on the Nervous System and Symmetry of the Crinoids,” Austin H. Clark.

Chemical Statistics.—“The Consumption of the Commoner Acids in the United States,” Charles E. Munroe.

Abstracts.—Geodesy; Meteorology; Terrestrial Magnetism; Electricity; Radio-telegraphy; Chemistry; Electrochemistry; Agricultural

Chemistry; Mineralogy; Geology; Botany; Forestry; Zoology; Conchology; Fisheries; Pharmacology; Bacteriology; Sanitation; Engineering.

Proceedings.—Washington Academy of Sciences.

SPECIAL ARTICLES

WHERE ARE THE LARAMIE DINOSAURS?¹

THE Ceratopsidæ or horned dinosaurs have so long been regarded by paleontologists and others as belonging to the Laramie formation, and also that this “Laramie formation” containing them is of Cretaceous age, that facts which seem to oppose this view make but slow headway. That the true Laramie is of Cretaceous age no one is likely to question at this stage of the discussion, but the mistake lies in presuming that the dinosaur-bearing beds belong to the Laramie. At the Baltimore meeting of the Geological Society of America (December, 1908) I ventured to say, in a public discussion of one of the correlation papers, that there was no known locality in North America where dinosaurs (Ceratopsidæ) occur in true, undoubted Laramie. To the best of my knowledge and belief that statement still holds good.

In June, 1909, I published a paper² in which the following is given as the thesis: “The present paper deals with the extensive series of fresh-water deposits of the northwest (*i. e.*, broadly, the region east of the Rocky Mountains and between Wyoming and the valley of the Mackenzie River) comprising what is here considered as the Fort Union formation. It is shown that the Fort Union embraces more than has been commonly assigned to it. Conformably below the beds by some geologists considered as the true Fort Union occur dark-colored sandstones, clays and shales, which have often been incorrectly referred to the Laramie, or its equivalents, but which are stratigraphically and paleontologically dis-

¹ Published with the permission of the director of the U. S. Geological Survey.

² “The Stratigraphic Relations and Paleontology of the ‘Hell Creek Beds’ and Equivalents, and their Reference to the Fort Union Formation,” *Proc. Wash. Acad. Sci.*, Vol. 11, 1909, pp. 179-238.

inct from the Laramie, and the contention is here made that these beds, which include the 'Hell Creek beds' and so-called 'somber beds' of Montana, the 'Ceratops beds' or 'Lance Creek beds' of Wyoming, and their stratigraphic and paleontologic equivalents elsewhere, are to be regarded as constituting the lower member of the Fort Union formation and are Eocene in age."

In that paper it was shown that the dinosaur-bearing beds ("Ceratops beds") rest, in some cases unconformably, in others in apparent conformity, on Fox Hills or Pierre, and the conclusion was reached that an erosional interval is indicated during which the Laramie—if ever present—and other Cretaceous and early Tertiary sediments were removed. From this it follows that the beds under consideration, being above an unconformity, can no longer be considered as a part of the "Conformable Cretaceous series," and hence are not Laramie. It was also shown that these beds can not be separated on structural or lithologic grounds from the overlying acknowledged "yellow"-bed Fort Union; in other words, that sedimentation was continuous and uninterrupted.

The results of the work of two field seasons in critical areas have just been published (June, 1911),³ showing that the results of the first paper are confirmed in every particular. For instance, on the North Platte River, opposite the mouth of the Medicine Bow River, in Carbon County, Wyoming, remains of *Triceratops* were found in beds (typical "Ceratops beds") above 6,000 feet of undoubted Laramie, and from which they are separated by an unconformity which, according to Veatch, has involved the removal of over 20,000 feet of strata. This would seem forever to dispose of the contention that the "Ceratops beds" are in any way the equivalent of the Laramie. A short distance to the northeast of this locality, in Converse County, Wyo., the Laramie is entirely absent and the dinosaur-bearing beds rest without observed

unconformity on Fox Hills. In adjacent South Dakota and southeastern Montana these same beds rest on Fox Hills of varying thickness, often with obvious erosional unconformity, occasionally also with angular as well as erosional discordance, and, in one instance, apparently on Pierre, the whole of the Fox Hills being cut out.

In 1910 the U. S. Geological Survey formally adopted the name *Lance formation*⁴ in place of "Lance Creek beds" or "Ceratops beds." Wherever *Lance formation* is employed it is to be understood as including "Lance Creek beds," "Ceratops beds," "Hell Creek beds," "somber beds," "Lower Fort Union" and dinosaur-bearing beds identified as "Laramie" by many writers.

At first the Lance formation was considered to be of Cretaceous age, though obviously above and distinct from the Laramie. Later, however, when the facts became known as above outlined, and when it became necessary to place the Lance formation officially⁵ it has been recorded as "Cretaceous or Tertiary." This concession is regarded by the writer as important, and one the value of which is not to be overlooked.

The vertebrate paleontologists⁶ continue to refer to the "Ceratops beds" as the "Laramie," the "Laramie Cretaceous," etc., as though nothing had been ascertained regarding their position since they were named twenty-five years ago! If there is valid evidence to show that the Lance formation ("Ceratops beds") is the equivalent of the Laramie in whole or in any part it would be welcome. If there is a known locality where dinosaurs (*Ceratopsidae*) occur in the true Laramie, information concerning it should not longer be withheld.

F. H. KNOWLTON

⁴ See first use, *Am. Jour. Sci.*, Vol. 30, September, 1910, p. 172.

⁵ Cf. Bull. U. S. Geol. Surv., No. 431 B, 1911, p. 85.

⁶ Cf. Lull, *Am. Jour. Sci.*, Vol. 29, 1910, pp. 1-39; Brown, *Bull. Am. Mus. Nat. Hist.*, Vol. 28, 1910, pp. 267-274; Wieland, *Am. Jour. Sci.*, Vol. 31, 1911, pp. 112-124.

³ "Further Data on the Stratigraphic Position of the Lance Formation ('Ceratops Beds')," *Jour. Geol.*, Vol. 19, 1911, pp. 358-376.